BIOREMEDIATION OF TETRACYCLINE HYDROXIDE (BIO POLLUTANT) USING CALCIUM OXIDE - ACTIVATED CARBON NANOCOMPOSITE SYNTHESIZED FROM CHICKEN EGG SHELLS

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ABSTRACT

In the contemporary world, the major threat posed to sustainable living is pollution. Thisresearch work aims to combat ways to remediate water pollution using Calcium Oxide- activated carbon nanocomposite. The nanocomposite used in this study was derived from Chicken eggshell waste as it is a rich source of Calcium. Calcium oxide nanoparticles were synthesized for enhanced performance due to its higher surface area to its volume ratio; it imparts size-dependent properties like higher adsorption tendency. CaO nanoparticles have proven to eradicate harmful metals in polluted water but on the other hand, CaO along with activated carbon is found to be more effective in treating bio pollutants in contaminated water. Hence, in the present study, Calcium oxide was combined with commercially procured activated carbon, and this nanocomposite was used as a potent adsorbent in the bioremediation of Tetracycline hydroxide in polluted water. The nanoparticles were characterized by XRD, FTIR, DLS, HR-SEM AND EDAX. Then the water sample synthesized with the bio pollutant Tetracycline hydroxide was tested for bioremediation efficiency using Calcium oxide - Activated carbon nanocomposite. The degradation of Tetracycline Hydroxide (TCH) was calibrated using a UV spectrophotometer and the degradation percentage was calculated. The UV spectrophotometer results validated that there is 83.12% degradation in the harmful pollutan from the water sample for a period of 5 hours of treatment. This research is an eyeopener as no other experimental work has been done on

bioremediation of harmful bio pollutant Tetracycline hydroxide using Calcium oxide-Activated carbon nanocomposite synthesized from chicken eggshell waste using green synthesis.

Key words: Chicken eggshell, nanocomposite, bioremediation, green synthesis, tetracycline hydroxide.

1. INTRODUCTION

The water and soil pollution create a major threat to sustainable living (Weilai Wang *et.al,* 2023). To solve this issue nanoparticles were being used. This synthesis of metal oxide nanoparticles has acquired momentum among the research community because biological synthesis of nanoparticles is the easiest, most affordable and environmentally friendly method (Momeni and Mohammad Meshkatalsadat, 2023)**.** The main objective for the use of nanoparticles is attributed to their size ranging from 1 to 100 nm. The primary advantage of green synthesis is that these particles will not lead to secondary pollution in the treated environment. Eggshells which are easily available at home, restaurants, bakeries etc. the major constituents of this eggshell are pristine, non-porous calcium carbonates. These eggshells, which were once considered waste, can be exploited in various applications which include abrasives, adsorbents, many metal ions and organic dyes. calcium oxide nanoparticles were synthesized for enhanced performance due to its higher surface area to its volume ratio, it imparts size-dependentproperties like higher adsorption tendency and large volume wastewater treatment systems (Jalu *et.al,* 2021).

Hao *et.al.,* (2021) established through his research that Activated carbon and biochar can be used as a potent agent produced through in situ process through permeable reactive barriers to eradicate lead from contaminated soil. Remediating contaminated groundwater poses substantial technological and economic hurdles, primarily originating from the intricate nature of the soil-water interface, prominently due to its heterogeneity and complexity. In this present study, we have used CaO-AC nanocomposite in treating water as an adsorbent in bioremediation. CaO nanoparticles have proven to eradicate harmful metals in polluted water but on the other hand CaO along with activated carbon is found to be a more effective in treating biopollutants in contaminated water. In this present study, CaO was combined with activated carbon nanoparticles, and the nanocomposite was used for water remediation.

2. METHODOLOGY

2.1 Nanosynthesis

Preparation of Eggshell powder

The eggshells of normal hybrid chicken eggs available in the market is procured as a household waste. The shells are washed initially with tap water, followed by washing with distilled and double distilled water. These eggshells were microwaved for 45 seconds in 120 degrees Celsius under standard lab conditions. These dried eggshells were transferred to a motor and pestle and grinded for 2 hours until it becomes fine powder. This compound is then sieved using a fine poresized sieve and transferred into a sterilized vial.

2.2 Annealing Eggshell

Annealing eggshells at 850 degrees Celsius.

2.3 Procurement of Activated Carbon

The Activated carbon used in this research is procured as a commercially available activated carbon.

### 2.4 Preparation of CaO-AC nanocomposite

Nanocomposite is prepared by powder mixing method where activated carbon and Calcium oxide is mixed in 2:1 ratio. Activated carbon is used as a support system to enhance thedegradation of bio pollutants (Alobaidi and Mohammed, 2021).

2.5 Characterization of CaO-AC nanocomposite

The CaO-AC nanocomposite is characterized using XRD, FTIR, HR-SEM and EDAX.

2.6 Bioremediation and Degradation of Treating tetracycline Hydroxide in Water usingCaO-AC Nanocomposite

10mg of Tetracycline Hydroxide is measured accurately using a digital balance and introduced into a conical flask containing 500mL of distilled water. Then 30 mL of this solution is measuredand transferred to a beaker to which 50mg of CaO-AC nanocomposite is added. This sample is
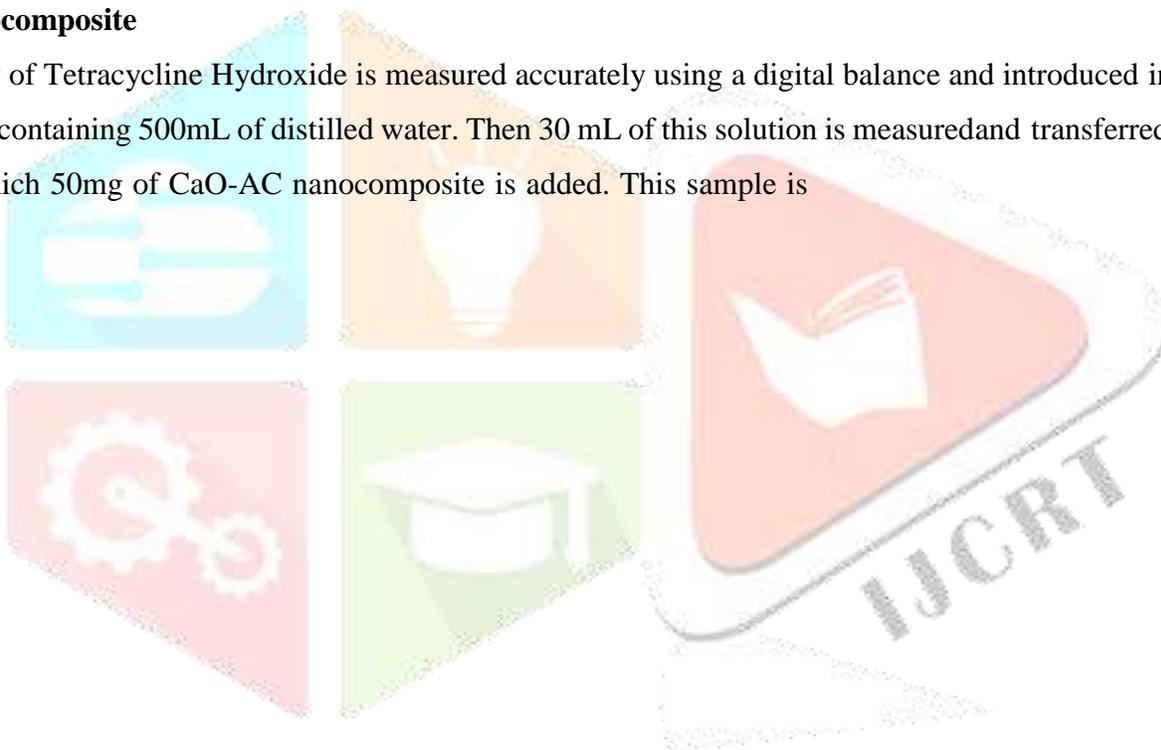
kept in the stirrer for 5 hours. Then UV analysis is done for the Control water sample and treatedwater sample.

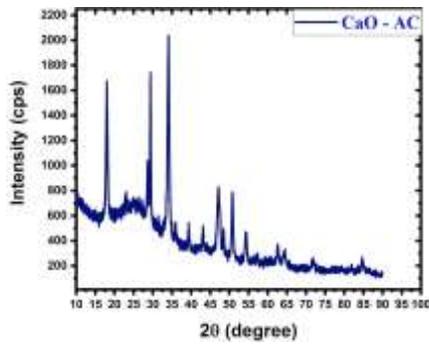## 3. RESULTS AND DISCUSSION

XRD OF CaO-AC   FTIR ANALYSIS OF CaO-AC
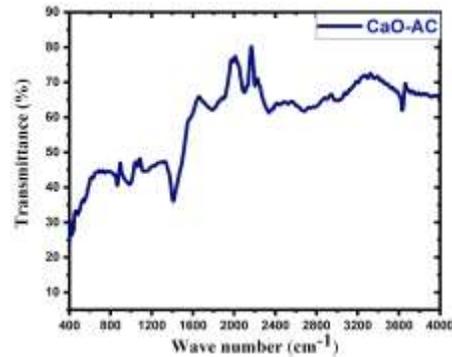
Figure 1: The XRD pattern of Cao-AC   Figure 2 : FTIR pattern of Cao-AC

HR-SEM AND EDAX PATTERN OF CaO-AC

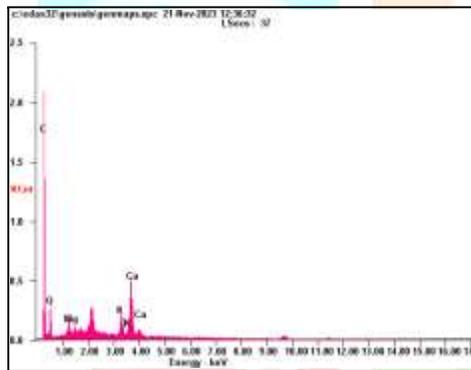| Element	Wt%	Ar%
CK	74.32	81.77
OK	19.12	15.79
MgK	01.26	00.68
KK	01.41	00.48
CaK	03.88	01.28
Matrix	Correction	ZAF

Figure 4 : HR SEM and EDAX ofCaO-AC
Figure 3 : EDAX of CaO-AC
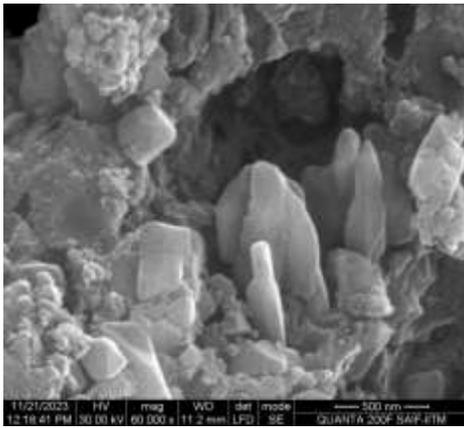
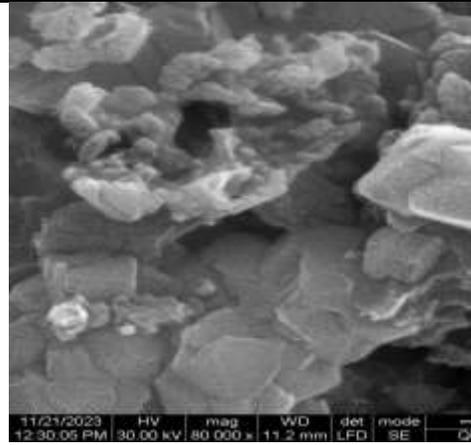**Figure 5: HR SEM OF CaO-AC**   **Figure 6: HR SEM of Cao-ACUV ANALYSIS OF**

CaO-AC

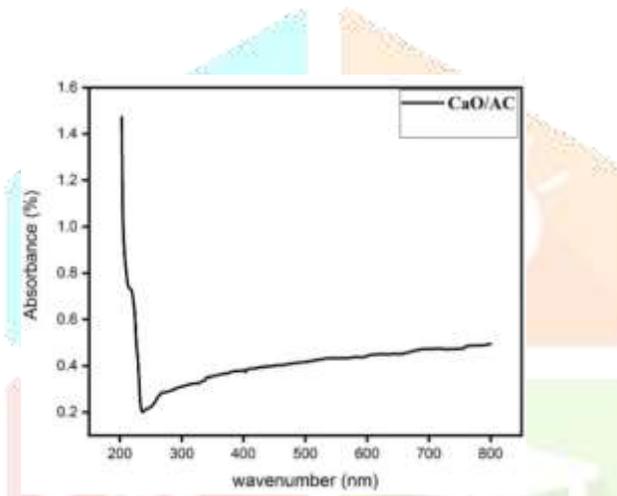Figure 7 : UV analysis of CaO-AC   Figure 8 : UV analysis of CaO-AC
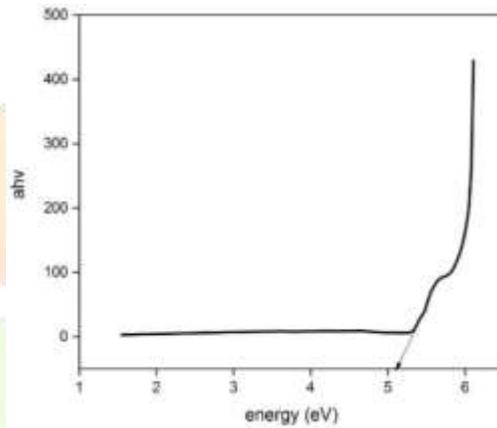
TETRACYCLINE HYDROXIDE DEGRADATION USING CaO-AC:

C_0	Output concentration/ Final concentration
C_i	Initial concentration
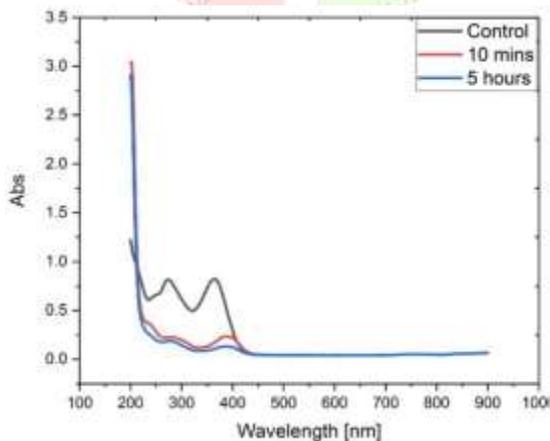
Figure 9 : Degradation of TCH by CaO-AC

Degradation efficiency of $= (C_t - C_o / C_t) \times 100$ Tetracycline hydroxide by CaO-AC

$= (0.845 - 0.1426 / 0.845) \times 100$

$$= 0.8312 \times 100$$

Degradation efficiency

of TCH by CaO-AC   **= 83.12%**

In figure 1, the XRD pattern of CaO has characteristic peaks 2 theta values of 32.38, 54.01 and 64.3 which closely resembles with JCPDS (Joint Committee on Powder Diffraction Standards) 77-2376, results by (Kasiranjan *et.al.,* 2022). It is reported that these CaO nanoparticles were used to eradicate lead. The present study shows the diffraction peaks for Activated carbon were obtained at 20.480, 23.540, 25.180, 27.290, 29.290, 31.600, 35.590, 36.160 which is in line with the diffraction peaks obtained by Aravind M, Amalanathan M(2020). So, this confirms the presence of both calcium oxide and activated carbon in the sample. In figure 2, the FTIR pattern of CaO has a characteristic peak at 1064.51 cm⁻¹,1444.42 cm⁻¹which is in line with the results observed by Lulit Habte et.al.,(2019). The characteristic peak values obtained in the present study indicates the presence of various functional groups andbonds between carbon. The figure 2, shows the FTIR spectra of activated carbon, a peakobserved at 779cm⁻¹ signifies the presence of C-H bond, 677cm-1 confirms the presence of C-C bond, 3424cm-1 is a wide peak which indicates the presence of due to the alcohol and phenol presence. All of the obtained results are in corroboration with the results obtained by (Aravind and Amalanathan,2021). This characterizes the presence of both CaO along with Activated carbon in the nanocomposite.

The results of HR-SEM revealed the structure of CaO-AC nanocomposite in figure 5 and 6. The activated carbon being amorphous in nature, does not have a definite shape and structure, and therefore appears as irregularly shaped structures which is exactly coinciding with the SEM results for activated carbon obtained by (Aravind and Amalanathan,2021).

But CaO being crystalline in nature, appears to be in definite shape and crystalline structure which is the same as the results obtained by Masoumeh Keihani *et.al.,* (2018). This nanocomposite was used to treat Tetracycline hydroxide, which is a common bio pollutant in water. The degradation of Tetracycline Hydroxide (TCH) was interpreted using UV and also the degradation percentage of TCH was calculated. UV analysis of this water treatment (figure 9), reveals that the Cao-AC nanocomposite is 83.12 % efficient in tetracycline hydroxide removal from the aqueous solution. The UV for CaO-AC is used to find the bandgap.

4. CONCLUSION

To enhance the bioremediation potential, CaO nanoparticles synthesized from eggshells, were combined with Activated Carbon (commercially procured) and this Nanocomposite was used in the present study. The characterization of CaO-AC was done using XRD, FTIR, and HR-SEM. Since the results are promising, more extensive work can be done to explore and optimize the bioremediation potential of CaO-AC nanocomposite.

5. REFERENCES

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